CLAIMS

WE CLAIM AS OUR INVENTION:

1. A catalytic combustor comprising:

a first catalytic stage comprising a metallic catalyst support and receiving an oxidizer and a fuel and discharging a partially oxidized fuel/oxidizer mixture;

a second catalytic stage comprising a ceramic reticulated foam catalyst support disposed within a pressure boundary defining a pressure boundary cross-sectional flow area, the foam catalyst support receiving a first portion of the mixture and presenting a support cross sectional flow area less than the pressure boundary cross-sectional flow area to define a bypass passageway for allowing a second portion of the mixture to bypass the foam catalytic support, the second catalytic stage having an outlet temperature elevated sufficiently to completely oxidize the mixture without using a separate ignition source; and

an oxidation completion stage disposed downstream of the second catalytic stage for recombining the first and second portions of the mixture and completing oxidation of the mixture.

2. The catalytic combustor of claim 1, wherein the second catalytic stage further comprises a catalytic material selected from the group consisting of perovskite, zeolite, and hexaaluminate.

3. The catalytic combustor of claim 1, wherein the bypass passageway is disposed around a portion of a perimeter of the ceramic reticulated foam catalytic support.

4. The catalytic combustor of claim 1, wherein the ceramic reticulated foam catalytic support comprises a cruciform cross-section.

5. The catalytic combustor of claim 1, wherein the ceramic reticulated foam support comprises a donut-shaped cross-section.

6. A catalytic combustor comprising:

a first catalytic stage receiving an oxidizer and a fuel and discharging a partially oxidized fuel/oxidizer mixture; and

a second catalytic stage receiving the partially oxidized fuel/oxidizer mixture and further oxidizing the partially oxidized fuel/oxidizer mixture, the second catalytic stage comprising a passageway for conducting a bypass portion of the partially oxidized fuel/oxidizer mixture past a catalyst disposed therein and having an outlet temperature elevated sufficiently to complete oxidation of the partially oxidized fuel/oxidizer mixture without using a separate ignition source; and

an oxidation completion stage disposed downstream of the second catalytic stage recombining the bypass portion with a catalyst exposed portion of the partially oxidized fuel/oxidizer mixture and completing oxidation of the partially oxidized fuel/oxidizer mixture.

7. The combustor of claim 6, further comprising a transition stage disposed between the first catalytic stage and the second catalytic stage, the transition stage comprising a narrowed flow area region disposed between an inlet end receiving the partially oxidized fuel/oxidizer mixture from the first catalytic stage and an outlet end discharging the partially oxidized fuel/oxidizer mixture into the second catalytic stage.

8. The combustor of claim 6, wherein the second catalytic stage further comprises a catalytic material selected from the group consisting of perovskite, zeolite, and hexaaluminate.

9. The combustor of claim 6, wherein the second catalytic stage further comprises a first region comprising a first catalytic material, and a second region disposed downstream of the first region and comprising a second catalytic material different from the first catalytic material.

10. The combustor of claim 6, further comprising:

a first catalytic material disposed on a metallic support in the first catalytic stage; and

a second catalytic material, different from the first catalytic material, disposed on a ceramic support in the second catalytic stage.

11. The combustor of claim 6, wherein the second catalytic stage further comprises a metallic support comprising a metal alloy selected from the group consisting of molybdenum disilicide, iron-chromium-aluminum, and iron aluminide.

12. The combustor of claim 6, wherein the second catalytic stage further comprises a catalytic material disposed on a ceramic reticulated foam catalyst support.

13. The combustor of claim 6, wherein the second catalytic stage further comprises a plurality of separate catalytic elements disposed along a flow axis of the combustor.

14. The combustor of claim 13, wherein the separate catalytic elements comprise ceramic reticulated foam catalyst supports comprising different pore size grades.

15. The combustor of claim 13, wherein the separate catalytic elements comprise different cross-sections.

16. The combustor of claim 13, wherein the separate catalytic elements comprise different catalytic materials.

17. The combustor of claim 13, wherein each catalytic element comprises an identical cross-section and is angularly rotated about the flow axis with respect to an adjacent catalytic element to cause mixing of a flow about the flow axis.

18. The combustor of claim 13, wherein each catalytic element is spaced apart from an adjacent catalytic element along the flow axis.

19. The combustor of claim 6, wherein the second catalytic stage further comprises a tubular catalyst support coated with a catalytic material on an outside surface and an inside surface.

20. The combustor of claim 6, wherein the second catalytic stage further comprises a plurality of catalytic material coated plates defining longitudinal passageways.

21. The combustor of claim 6, wherein the second catalytic stage further comprises a catalyst support selected from the group consisting of a honeycomb structure, a tower packing structure, and a packed particle structure.

22. The combustor of claim 6, wherein the first catalytic stage comprises a rich catalytic stage.

23. The combustor of claim 6, wherein the second catalytic stage comprises a lean catalytic stage.

24. A catalytic combustor comprising:

a pressure boundary defining a pressure boundary cross-sectional flow area for conveying a fuel/oxidizer mixture; and

a catalyst-coated reticulated foam support disposed within the pressure boundary for receiving a first portion of the mixture and presenting a support cross-sectional flow area less than the pressure boundary cross-sectional flow area to define a bypass passageway for allowing a second portion of the fuel/oxidizer mixture to bypass the foam support.

25. The catalytic combustor of claim 24, wherein the reticulated foam support comprises a cross-section sized to bypass from 25% to 80% of the mixture past the foam support element.

26. The catalytic combustor of claim 24, wherein the reticulated foam support defines a plurality of separate passageways within the pressure boundary.

27. The catalytic combustor of claim 24, wherein the passageway is disposed around a portion of a perimeter of the reticulated foam support.

28. The catalytic combustor of claim 24 wherein the reticulated foam support comprises a cruciform cross-section.

29. The catalytic combustor of claim 24 wherein the reticulated foam support comprises a donut-shaped cross-section.

30. The catalytic combustor of claim 24 wherein the reticulated foam support comprises a cross-section perimeter smaller than an internal perimeter of the pressure boundary, the foam support supported against the internal perimeter by spaced apart standoffs.

31. The catalytic combustor of claim 24 wherein the reticulated foam support comprises a ceramic material.